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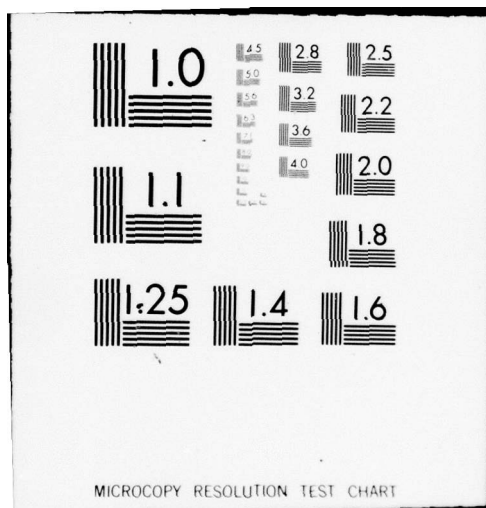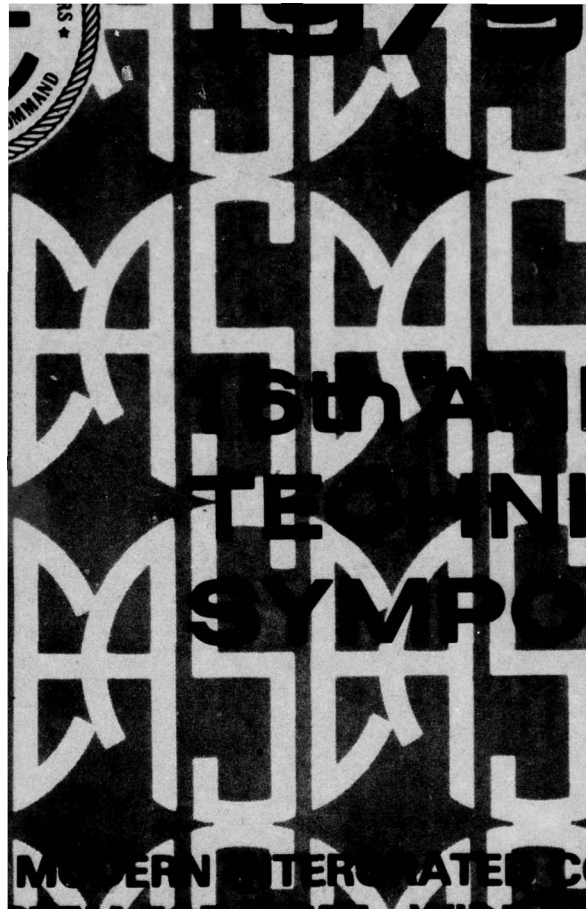MAR 79   J T MCDONNELL

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IVCS - A MODERN INTEGRATED COMMUNICATIONS SYSTEM FOR FLEET-WIDE APPLICATION

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ABSTRACT

IVCS is the Navy's newest and most modern interior communications system. It is the Navy's only qualified integrated shipboard voice distribution system, and received approval for service use in 1978. It operates under processor control to provide the high degree of flexibility demanded to meet the varied missions of today's naval vessels.

The production version of the first-generation system has been fully operational since 1975 and has produced favorable operational experience. System enhancements have been accomplished with an efficiency not previously seen in modifying interior communications systems. This ease of modification is a characteristic of the IVCS and its software control features, and will apply to all ships regardless of their type or mission.

A modified first-generation system is in the AEGIS base line, and many exciting innovations are planned to meet the AEGIS mission.

And finally, a second-generation system is being tested that increases the modularity, flexibility, and cost-effectiveness of the IVCS to enable fleet-wide application. The resulting system provides one common design for the 1980's which will satisfy all of the interior communication needs of the Navy - on all ships - from the smallest to the largest.

INTRODUCTION

The Integrated Voice Communication System (IVCS) was developed under the cognizance of the Naval Ship Engineering Center and was produced for installation on LHA Class Ships. The IVCS, which is nomenclatured AN/-STC-1, is the Navy's only qualified integrated shipboard voice distribution system, and it received full approval for service use in 1978 ... see figure 1. It operates under processor control to provide the high degree of flexibility demanded to meet the varied missions of today's naval vessels.

HISTORY OF INTERIOR COMMUNICATIONS

Effective interior communication is a basic requirement for any naval vessel. Communication efficiency and effectiveness is paramount in today's shipboard operations in which as many as two-thirds of the ship's company may use the system simultaneously. This use generates a constant flow of information and data which forms the basis for every decision and command at every organizational level. The combat effectiveness of every vessel, and of the fleet in general, is profoundly affected by the quality and utility of this equipment.

Pre-IVCS Stations

The interior communication requirements traditionally have been satisfied by a variety of means, including dial telephones, sound-powered telephones, one-way and two-way announcing systems, NTDS console interphones, and voice tubes. This traditional approach, with no interfacing of circuits, results in many key stations being provided with multiple circuits that present a confusing array of separate terminals to the operator ...see figure 2.

Traditional Approach vs. IVCS Approach

The traditional IC system is not really a system but simply an aggregate of individual circuits. To accommodate these circuits, separate cable runs and an enormous amount of cabling are required, ranging from 60,000 to 500,000 feet, depending on the class of ship. Such hard-wired systems have not changed appreciably over the last 35 years. These systems are inefficient and inflexible to the constantly changing communication needs of the fleet, and reconfiguration requires significant cable rerun. In addition, these nonintegrated circuits employ different communication techniques which have resulted in many different type instruments.

IVCS does away with these wasteful overlapping functions by providing a totally integrated system that uses the communications equipment more effectively, resulting in reduced overall cabling, fewer terminals, and

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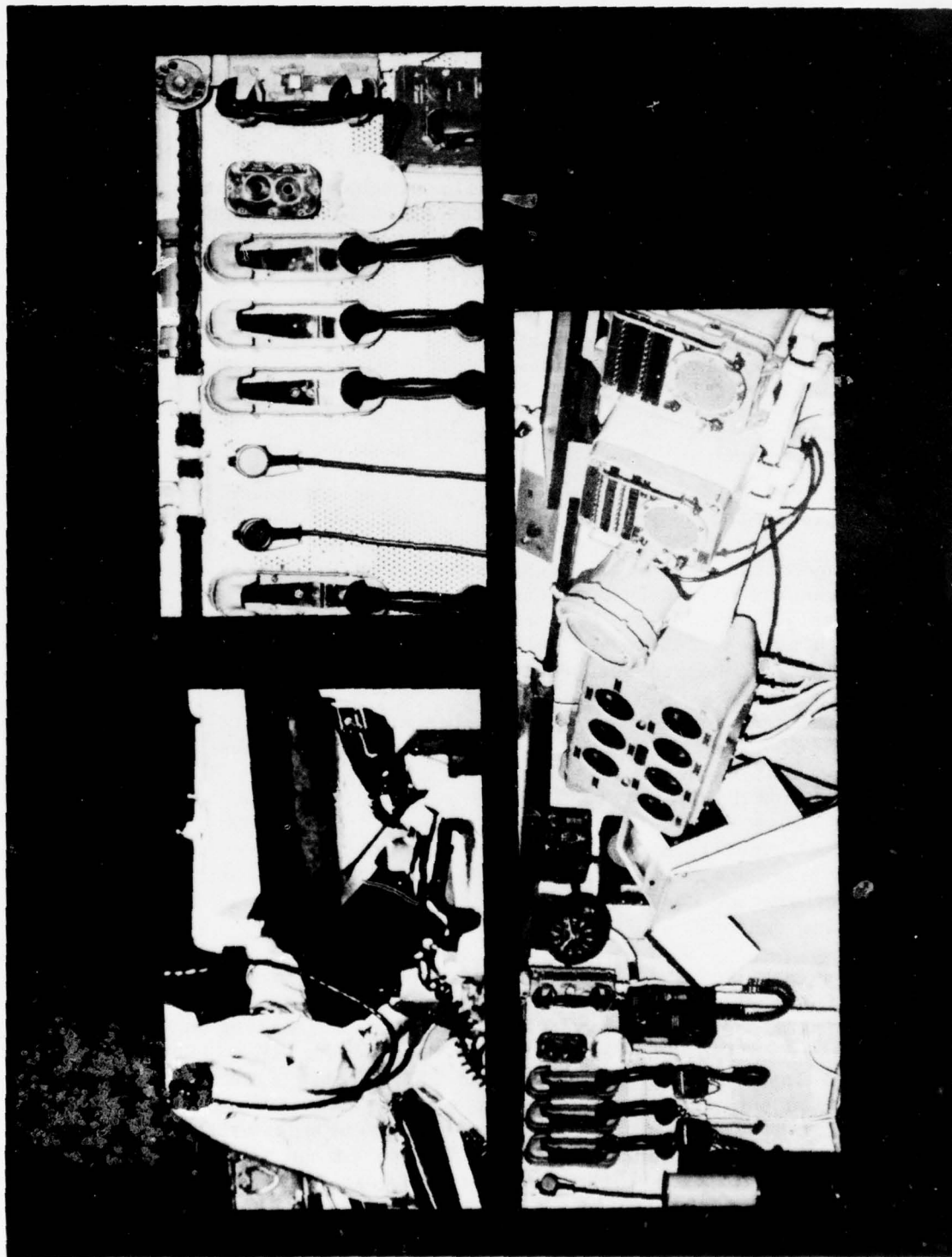FIGURE 1 IVCS RECEIVED FULL APPROVAL FOR SERVICE USE IN 1978

FIGURE 2 PRE-IVCS STATIONS

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easy reconfiguration through software changes. Total access to the system and all interfaces can be had from the same terminal.

Traditional IC systems have limited operational features, are marginally intelligible on multiparty nets, and often require talkers to relay messages.

The voice quality and intelligibility of the conventional IC equipment is far below the present state of the art. This is particularly evident when the circuits are loaded with relatively large numbers of users. Special training has been required to accustom the users to the poor fidelity and intelligibility.

On the other hand, IVCS has up-to-date communication features, provides superior voice quality and intelligibility, and enables direct communication without the aid of talkers.

IVCS Development

Recognizing the limitation of the traditional approach to interior communications, the Navy in late 1963 initiated a feasibility study to determine the overall communications requirements for Navy ships with a goal toward developing a single integrated communication system. The study resulted first in a feasibility model and later a development model of an Advanced Interior Communication System (AICS) utilizing a centralized switch, controlled by a stored program processor. This system was the forerunner to the present IVCS.

The development model was demonstrated and technically evaluated aboard the USS BUNKER HILL in 1969 ...see figure 3. Because of its success, the new system was selected for the LHA base line. Five systems were produced and delivered in 1972 for installation aboard LHA-1 through LHA-5. This production version has been fully operational since 1975 when LHA-1 went to sea. Additional operational experience has been obtained from LHA-2 and LHA-3 and the results have been favorable. This first-generation equipment is characterized in figure 3 by its five-rack switching center.

A three-rack version has been configured and is presently in the AEGIS base line. A one-rack version was demonstrated in 1978 and is planned to be installed in the Navy's Combat System Engineering Development Site - commonly called CSEDS - located in Moorestown, NJ. CSEDS is the test and development site for the AEGIS Ship Combat System. This second-generation equipment is the result of extensive effort to increase the modularity, flexibility, and cost-effectiveness of the IVCS to enable fleet-wide application. The result is one common design for the 1980's which will satisfy all the interior communications needs of the Navy - from the least sophisticated to the most - on all ships - from the smallest to the largest.
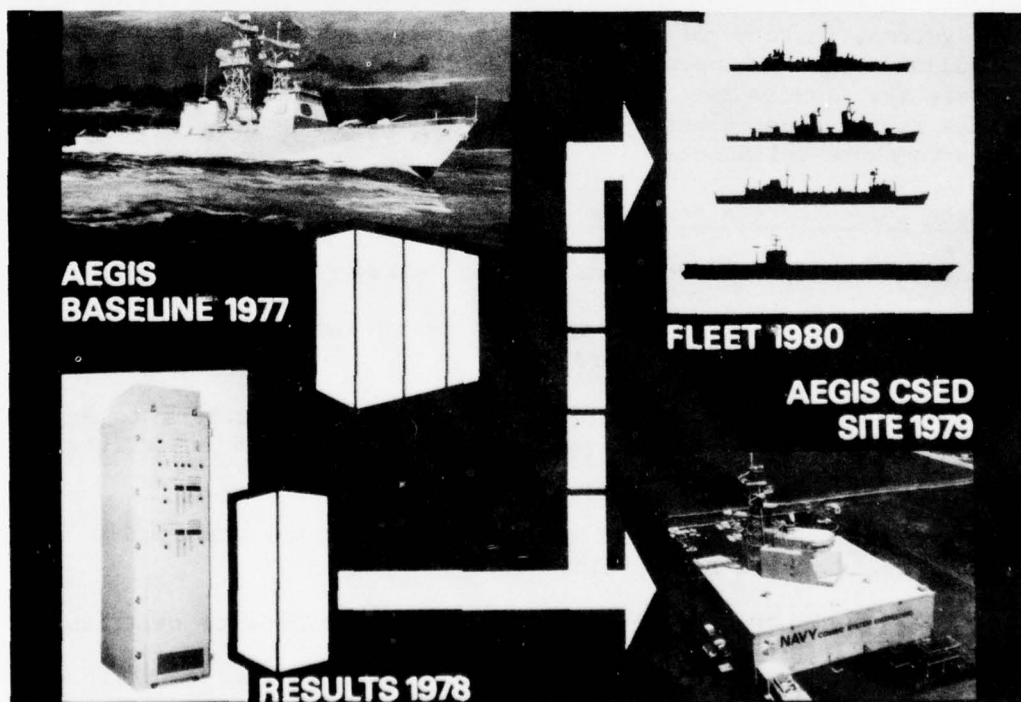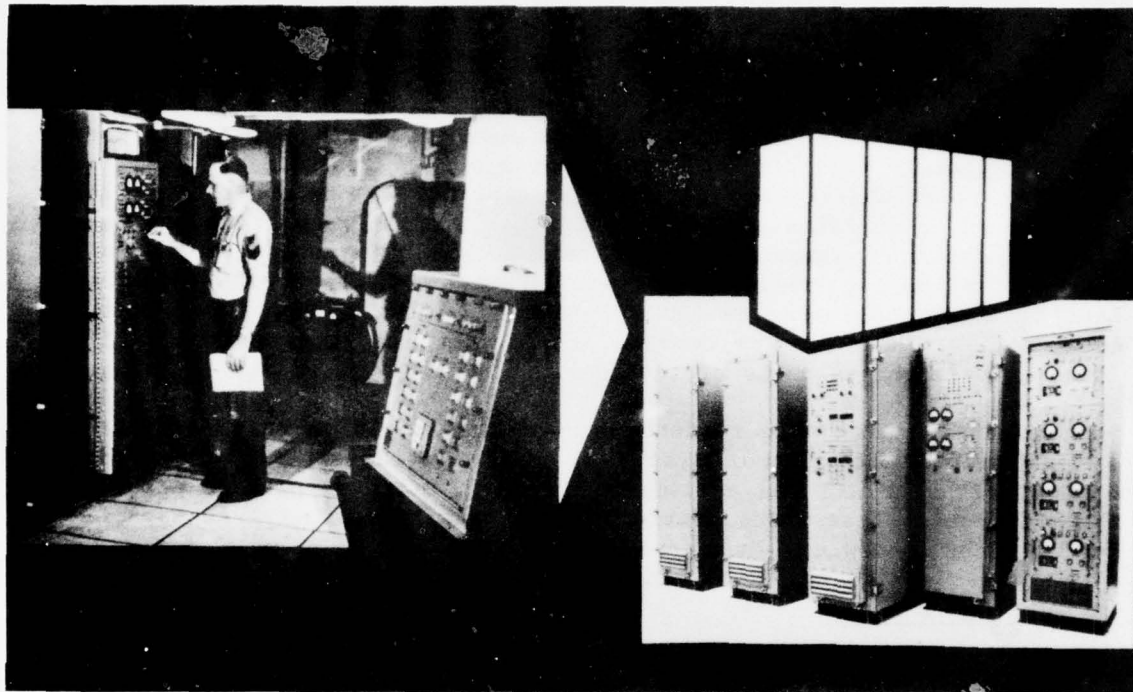
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FIGURE 3 IVCS DEVELOPMENT

IVCS APPLICATION TO LHA MISSION

Mission Requirements

The new LHA general-purpose amphibious assault ships perform missions which previously required four different types of vessels. The LHA is as large as an ESSEX Class carrier; it combines in one modern ship the features of an amphibious assault ship (LPH), amphibious transport dock (LPD), amphibious cargo ship (LKA), and dock landing ship (LSD). As a result, the LHA can transport and put ashore an entire Marine Battalion Landing Team consisting of 2000 Marines and their supporting combat equipment, and can provide command, communications, and control facilities for all the elements of the team.

Such a multipurpose ship requires one of the Navy's largest integrated communications and control systems to provide facilities for coordinating virtually all the activities inherent in an amphibious assault. The IVCS meets these needs completely and has the capacity and capability to adapt to new and increased mission requirements.

Operational Features

The IVCS,...see figure 4, combines the functions of the conventional Administrative Dial, Sound-Powered Net, and Intercom Systems. It has the additional capability of interfacing with several other voice communication systems, thereby making a greater variety of communication channels available to more operators with little or no increase in the requirements for terminals. The interfaces implemented in the LHA Class ships are radio, sound-powered net, man-on-the-move, general announcing, and ship-to-shore telephone.

Up-to-Date Communication Features

IVCS incorporates up-to-date communication features:

Four-digit pushbutton dialing. The ability to key four digits and be connected to any terminal on board ship.

Abbreviated addressing. The ability of selected subscribers to key a single button and be connected to any frequently called subscriber or net.

Call forwarding. The ability of selected terminals to temporarily forward their calls to another destination.

Privacy override. The ability of selected subscribers to override or "break-in" to existing connections on demand.
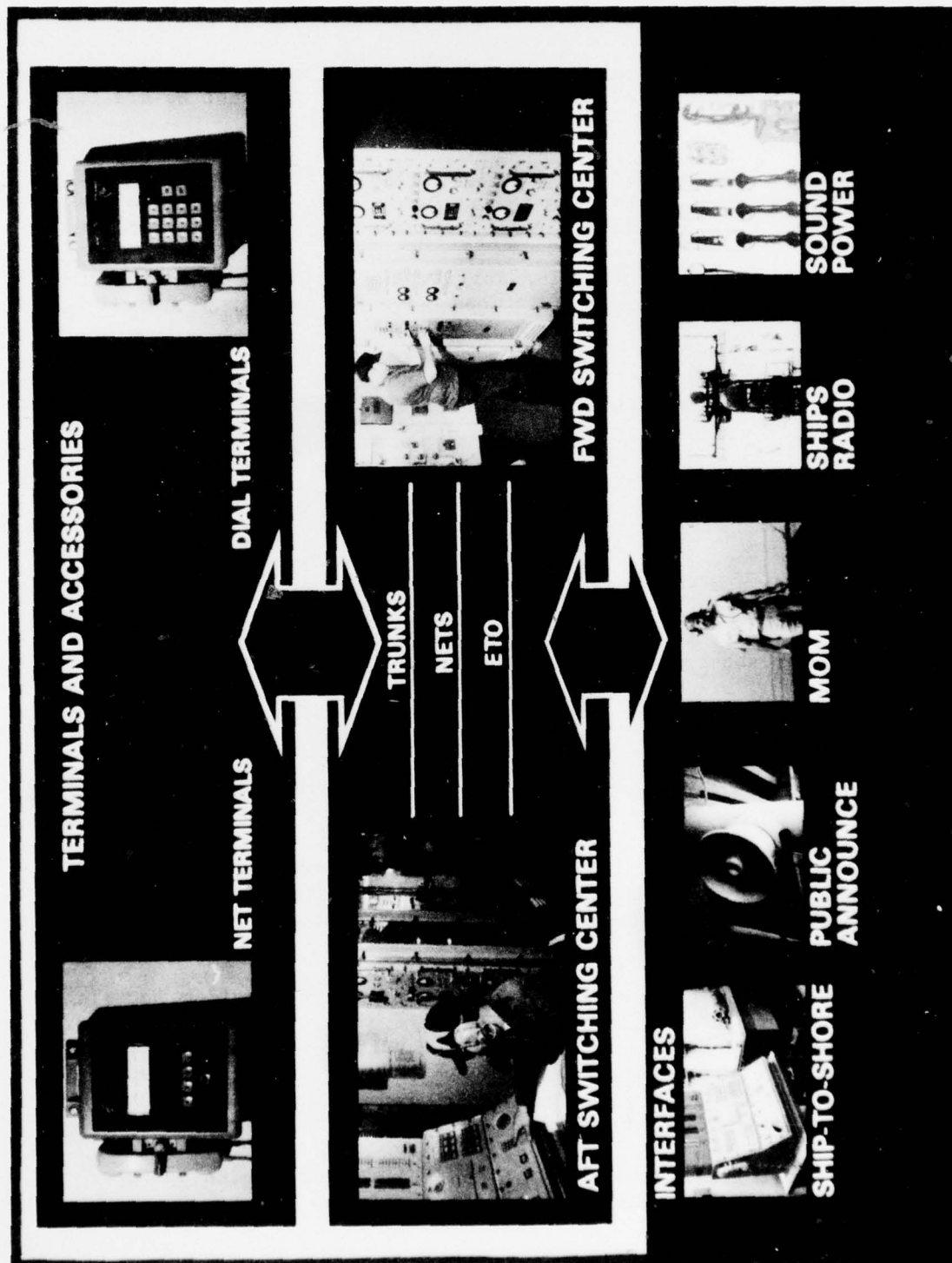
FIGURE 4 IVCS BLOCK DIAGRAM

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Ring override. The ability of a dial terminal (without privacy override) to signal to a busy terminal the existence of another call.

Hunt-not-busy groups. The ability to automatically reach any idle terminal in a common location or functional activity of interest by dialing one 4-digit number.

Command netting. The ability of selected subscribers to key in a command net code via abbreviated addressing or 4-digit dialing which will automatically ring and connect up to 30 preset subscribers into a net.

Versatile emergency reporting. The ability to receive automatic override service to predetermined locations when an emergency number is dialed.

Restricted access. The ability to limit selected terminals from calling other terminals thus providing executive right-of-way for high priority traffic.

Alternate address. The ability to have another designated dial terminal automatically ring when the called dial terminal is busy.

Dial-up conferencing. The ability of selected terminals to dial directly a number of random subscribers into a conference call.

Preset conferencing. The ability of selected terminals to dial a fixed set of selected subscribers into a conference call using one dialing code.

Automatic answer and terminate. The ability of the recipient of the call to conduct hands-free communication.

Performance Features

IVCS performance will be considered in six categories. The IVCS is practical, automatic, flexible, survivable, expandable, and maintainable. In addition, it makes more effective and more efficient use of communications equipment.

Practical. The IVCS is practical in many ways. It provides superior voice quality and intelligibility. The terminal-to-terminal frequency response is better than $\pm$ 3 dB from 300 to 6000 Hz referenced to 1 kHz, and the terminal-to-terminal distortion over the output voltage range of the terminal at 1000 Hz is less than 5.0%. This is significantly better than that of sound-powered telephones.

IVCS results in a greater simplification of equipment at the operator's station. The IVCS terminal can replace the sound-powered telephone,

jackboxes, and selector switches as well as the microphone control stations, radio remote telephone units, MC intercommunications units, and the dial phone. The IVCS terminal can communicate to any other terminal: dial or automatic, net or even sound-powered telephones. For example, on LHA, IVCS has greatly simplified the Primary Flight Control Station (PRI-FLY) by giving the Air Boss and his assistant a 10-push-button handset selector panel and putting loudspeaker extensions on each PRI-FLY terminal. Now the Air Boss and his assistant truly only interface with one device for all their multiple communication functions.

<u>Automatic.</u> The IVCS provides automated operation in many ways. Some of these are:

● Automatic signalling and switching to all dial terminals, without the need for dedicated signalling circuits as presently provided on a selected basis.

● Automatic answering, release, and talk/listen control of incoming calls. This feature permits hands-free communication to the recipient of the call.

● Automatic test programs to facilitate system checking and maintenance.

Additional automatic operations discussed previously include abbreviated addressing, preset conferencing, command net operation, and privacy override.

<u>Flexible.</u> Flexibility of configuration and operation is a marked advantage of the IVCS when compared to conventional equipment with its rigid structure and separate cable runs.

● IVCS facilitates making the changes and rearrangements that are frequently required during ship design and construction, and at many points during the ship's lifetime. Many of these changes can be made through software alone, and most of the others require only modest changes in wiring.

● Central switching arrangement is especially amenable to temporary patching of special circuits or configurations to meet specialized requirements or emergency situation.

● System software package enables changes in configuration and operation to be made by ship's company - the IC technician in all cases - without the need for special training in programming. These changes are accomplished using the Maintenance Terminal which is a standard dial terminal unit. Ready control of seven classes of permits are provided and special emergency numbers can be set up or changed.

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<u>Survivable.</u> IVCS is designed to withstand failure or destruction of as-
semblies or functions and still provide total or partial service. For
example, such major elements as one processor, one power supply, or
ship's power can be lost without any effect on operational performance.
Also, individual switches in the switching matrix can fail without any
noticeable degradation of service. This is due to the great redundancy
of paths within a switching center which will allow a high level of
failures before noticeable degradation.

There is also redundancy in terminal coverage at key stations in that
nearby terminals are connected to different switching centers - one to
the forward and the other to the aft.

Each switching center is supplied from ship's power but each contains
dual power supplies and battery backup systems allowing complete and un-
interrupted operation for one hour in case of a ship's power failure or
failure of the system's power supplies. Switchover is automatic if
ship's power fails. This one-hour duration can be extended with ad-
ditional batteries; but it is usually not required because of the re-
dundant prime power sources on board most ships. However, when LHA-2
broke its mooring during a storm in the Spring of 1978, the auxiliary
generators were unable to function due to the shallow waters in which
the ship rested. The standby batteries sustained the IVCS through bet-
ter than eight hours at normal communication load. So we see that the
one-hour rating - which is at peak load in arctic conditions - is quite
conservative under normal operation.

<u>Expandable.</u> The IVCS is expandable - it was designed in modular form to
perform its basic voice task, but it was also provided with adequate
bandwidth and speed to accept signals outside the voice range. It has
the potential to serve as the basis for a totally integrated shipboard
communication system and operate as a common carrier for all electrical
signal transfer throughout the ship.

- Matrix configuration is modular to permit from 64 to 640 line termi-
  nations in each switching center.

- Matrix networks have sufficient bandwidth to handle traffic from dc
  to 100 kb/s. This far exceeds the requirements for voice-only traf-
  fic.

- System has the potential for operation as a Teletype Message Distri-
  bution System.

- System has the potential to function as an Information Transfer Sys-
  tem. IVCS can handle radio transfer switching, TV, miscellaneous
  sensor signals, alarms, and heading and gyro data.

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In fact, the IVCS Life Cycle Support Center in San Diego has two tele-type units installed to demonstrate the exchange of information via IVCS. They also have a closed-circuit television hookup which uses IVCS to transmit realtime signals between camera and monitor.

Maintainable. The improved maintainability of the system is a function of the IVCS design and the use of the fully duplicated stored program capability of the processor control.

● A program is provided to check the automatic switching matrix and cable continuity. When cable or matrix faults are detected, the identification of the faulty cable or matrix relay is printed out.

● All lines from the switching center to the terminals are individually fused at the center. This prevents the propagation of cable or terminal faults throughout the system that occurs on sound-powered telephone string circuits. Remote fuse alarms indicate fuse failure on a central control panel.

● Automatic monitoring and switchover is provided to control the operation of the dual redundant processors. This involves comparison of processors and automatic diagnostic checks when processors disagree.

● Automatic prime power monitoring is provided on a continuous basis. Although switchover of power supplies is manual, battery power sustains operation between fault and switchover.

● Software controlled maintenance includes programs for:

(1) Continuous tests such as the comparison of processors.

(2) Automatic periodic tests such as the cable and matrix fault checks and the processor diagnostics.

(3) Manually initiated tests using a library of internally and externally stored programs to facilitate system maintenance and troubleshooting.

(4) Utility service programs such as the "boot-strap" program for initial system startup.

More Effective Use of Hardware. IVCS offers a more effective utilization of communications equipment – it results in reduced overall cabling requirements, fewer terminals and a capability for reduction in operating and maintenance personnel. Up to 50% in cabling and cabling installation cost was saved in the LHA application.

The reduction in the number of terminals can also be significant. For

example, a 45% reduction is projected using IVCS instead of the conventional approach on Guided Missile Frigates. This reduction would be achieved through combinations of equipment at some stations, and would be achieved with no decrease in basic operating capability. The increased flexibility in the terminals and in their connectivity would not only permit this reduction but would in fact provide a great increase in efficiency and communication capability at each location.

SYSTEM DESIGN

The IVCS is primarily a voice network with a reed-relay space-division matrix. The system, ...see figure 4, consists of two centers, physically separated to lessen vulnerability, each servicing approximately half of the subscribers on board. Each center operates independently and is connected to the other via trunks and net "interties." The net intertie is a dedicated hardwire connection between centers allowing subscribers in both centers to access the same net. A net is equivalent to a sound-powered circuit. Trunk lines are randomly selected on a per-call basis, for the duration of the call, and connect subscribers in both ends of the ship. Each center is truly redundant and capable of taking over critical circuits should the other center sustain battle damage. The centers are identical except that one contains an additional semiautomatic switchboard for landline access when in port.

Typically on the LHA-1 Class ships, there are 60 trunks for interconnecting the centers and 40 nets which are continuous circuits through both switching centers. Seventy-three net phones are installed with access to one, two, three, or four nets. In addition, there are 60 radio nets, 30 in each switching center.

Each radio net has a dedicated net terminal, known as a Radio Remote Station (RRS), which guards or monitors the radio channel. There are an additional 58 net terminals or RRSs.

Two basic terminal types, ...see figure 5, were designed specifically for IVCS. One is a net terminal which provides access to preassigned net circuits only. The other is a pushbutton dial terminal which enables access to all authorized system interface, such as general announce, radio, man-on-the-move, sound-powered nets, and shore telephone.

There are variations of the basic terminals which fulfill special functions, such as the dial terminal extension, the net terminal extension, and the automatic dial terminal. The IVCS on the LHA-1 provides 553 dial terminals and 131 net terminals.

IVCS also provides six types of accessories, ...see figure 6: handset, headset, handset extension, standard and hands-free loudspeakers, and water-tight enclosure. Either type of terminal can accept any two
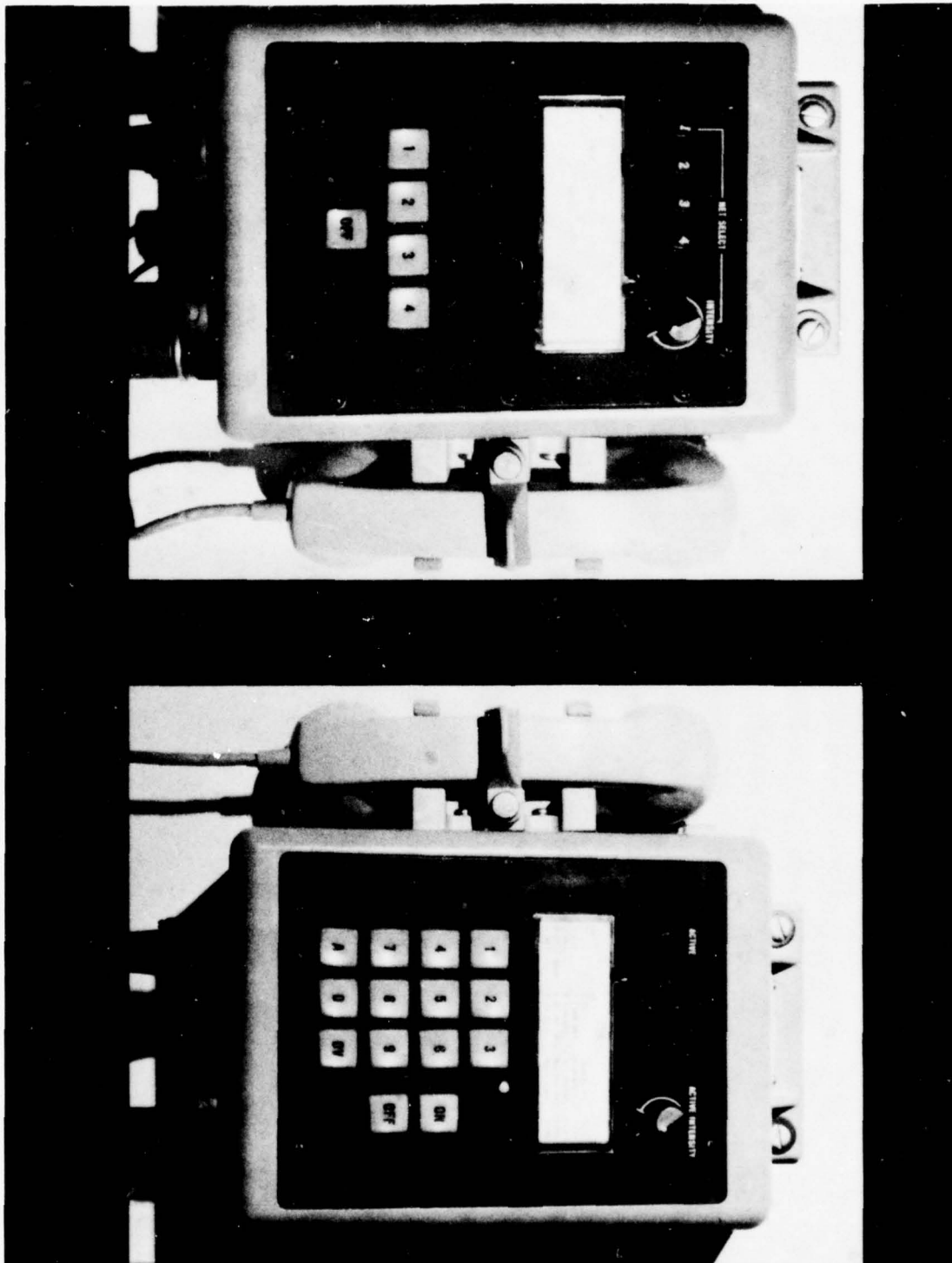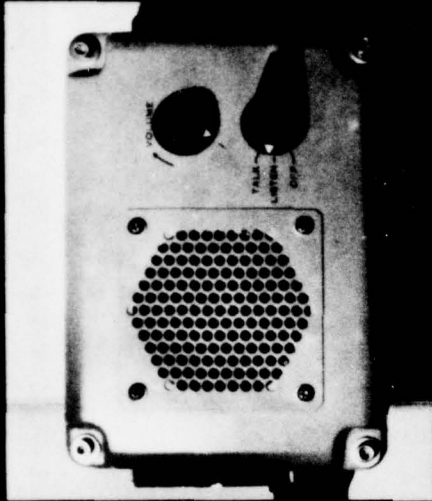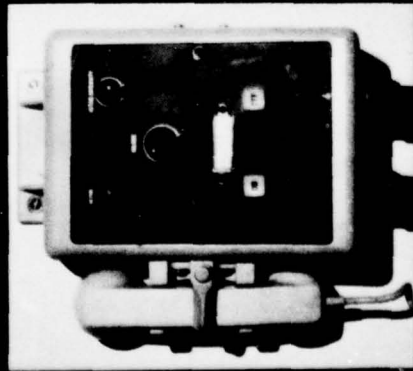
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FIGURE 5 DIAL AND NET TERMINALS

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ACCESSORIES

LOUDSPEAKERS

HEADSET

HANDSET

WATERTIGHT ENCLOSURE

HANDSET EXTENSION

FIGURE 6 ACCESSORIES

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accessories and can be mounted in the water-tight enclosure.

System Interfaces

General Announcing. A dial terminal, given the proper software permit, can access up to six combinations of loudspeaker groups to enable announcements over the ship's 1MC system.

Radio. The IVCS can provide the remote radio distribution function for the ship's exterior communication system. A total of 60 radio interface units are provided in IVCS; 30 interfaces in each center. An IVCS dial terminal, given the proper software permit, can access any one of the radio interface units. Net terminals or RRSs, as previously described, are assigned to the radio interface units to perform a continuous guard or monitor function.

Man-on-the-Move (MOMCOM). IVCS can extend to appropriate dial and net terminals access to the ship's six-channel MOMCOM or wirefree communication system. Each channel of the MOMCOM or system is interfaced with the IVCS system and is extended throughout the system by a net. The IVCS nets are net 77 through net 83. The first three nets (77, 78, and 79) correspond to the topside or aircraft-related channels; while the other three nets (81, 82, and 83) correspond to the well-deck-related channels.

Shore Telephone. IVCS allows dial terminals, with appropriate software permits, to access the shore telephone system when in port. The interface is accomplished through a semiautomatic switchboard which has the ability to connect up to eight Teleco or Autovon shore lines. This switchboard is also used to access the Marine Radio Relay system, the VCC-2, when at sea.

Sound-Powered. The IVCS also interfaces with up to ten sound-powered telephone circuits. The interface units normally connect the sound-powered circuit with an equivalent IVCS net to enable the small number of sound-powered users to communicate with the IVCS subscribers. An example of this is the JC Sound-Powered Weapons Control Circuit and the IVCS net 52 Weapons Control Circuit.

Key Design Features. Two key design features are hardware redundancy and software control.

Redundancy. Redundancy is the key to the unusually high reliability and survivability of the IVCS. Redundancy is provided for all critical common equipment. Its extent is well illustrated by the system block diagram, ...see figure 7, in which we see that the top half is the mirror image of the bottom.
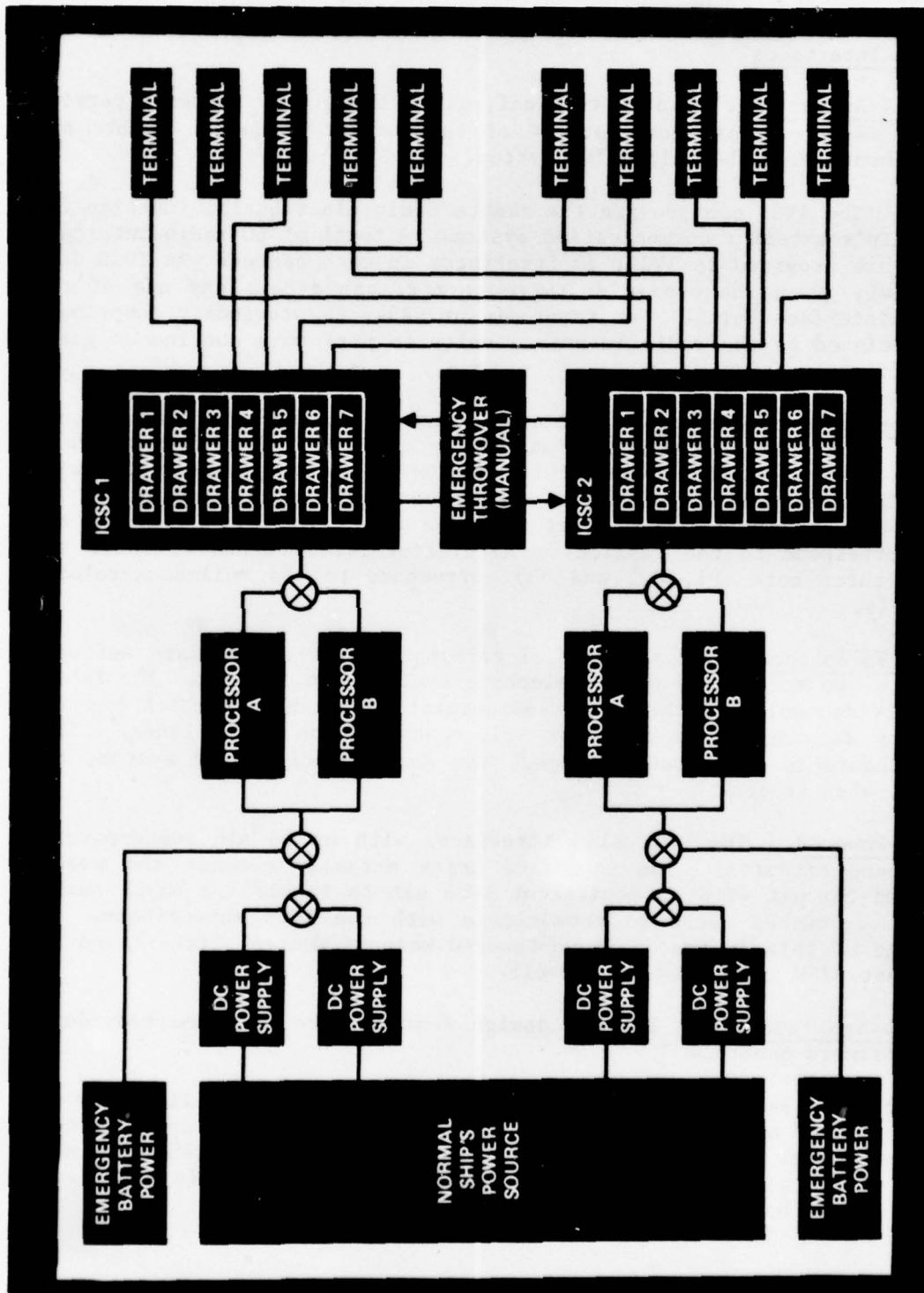
FIGURE 7 REDUNDANCY BLOCK DIAGRAM

The two processors in each center provide control redundancy and reliability.

The matrix is also redundant by design since multiple paths are available to complete any call. Failure of circuitry in the matrix can cause loss of service to a single terminal or group of terminals but it does not incapacitate the system. And as mentioned previously, each switching center has redundant 24-volt and 6-volt power supplies as well as an alternate battery source of power that is automatically available should normal power fail.

In addition, the redundancy in switching centers enhances system survivability through a degraded mode of system operation termed Emergency Throw-Over (ETO). When one switching center is inoperative, the 60 interconnecting trunks to that center are automatically switched to individual dial terminals, and the computer program treats the terminals on those trunks as subscribers of the operative switching center. These subscribers receive full IVCS services. Also in the ETO mode, 84 additional dial terminals receive partial IVCS service or access to emergency net E86 which is monitored in the aft IC room. As long as power is available in the inoperative center, full net terminal operation is maintained.

Software Control. Software control is key to the flexibility of the system. All desicions made by a switching center from the time a subscriber goes "off-hook" until he terminates the call are made by software. Hardware still provides hook status indication, tone generation and detection, and matrix connections; however, all of the hardware is controlled by software. All other hardware functions have been eliminated. Typical hardware functions now performed by software include:

(1) Timing and counting functions such as length of tones, length of dialing, and number of digits dialed.

(2) Hardware selection of, for example, idle paths in the matrix.

(3) Signalling tone validation, which involves examination of the type and identity of keyed digits.

(4) Number translation, that is, the correlation of a dialed number to an equipment location including AA, nets, and remote numbers.

(5) Current status recording of all terminals and hardware.

(6) Generation of all I/O commands to operational hardware and utility equipment.

(7) On-line fault detection and status of all critical hardware.

(8) Individual subscriber permits and accesses.

SUPPORT

A key element in the success of IVCS has been the continuous training
and overall support, provided by the Life Cycle Support Facility (LCSF)
at the Naval Training Center in San Diego, California. The LCSF is
administratively and technically staffed by NAVSEACENPAC.

Mission

Training includes both classroom and hands-on instruction in an equip-
ment lab, ...see figure 8, with both areas of training integrated for
maximum benefit to the students. The same equipment lab doubles as the
equipment test bed for life cycle support.

The primary mission of the LCSF is three-fold: (1) It functions as a
software support center, providing programming to support necessary and
desirable system changes in order to accommodate new mission require-
ments, to incorporate new equipments, and to adjust to the needs of new
personnel. (2) It assists in performing equipment design corrections
aboard ship. (3) It recommends design improvements to enhance the per-
formance of the IVCS in meeting its mission.

In performing this role, the LCSF performs configuration control, peri-
odically audits status of the IVCS systems, supplies emergency spares,
provides on-call 24-hour maintenance, evaluates proposed shipboard
changes, tests and processes high cost repair items, and publishes
training and support documentation.

Enhancements

The LHA-1 INSURV and OPEVAL trials identified the need for modifications
to enhance the operation of the system. The detailed design for a num-
ber of significant enhancements was accomplished by the LCSF. Some of
the more significant enhancements were:

(1) New net for use by bearing takers during maneuvering operations.

(2) Installation of six 10-pushbutton multiple station selector panels
    to provide increased operator access to circuits.

(3) Addition of an extensive EW alert circuit.
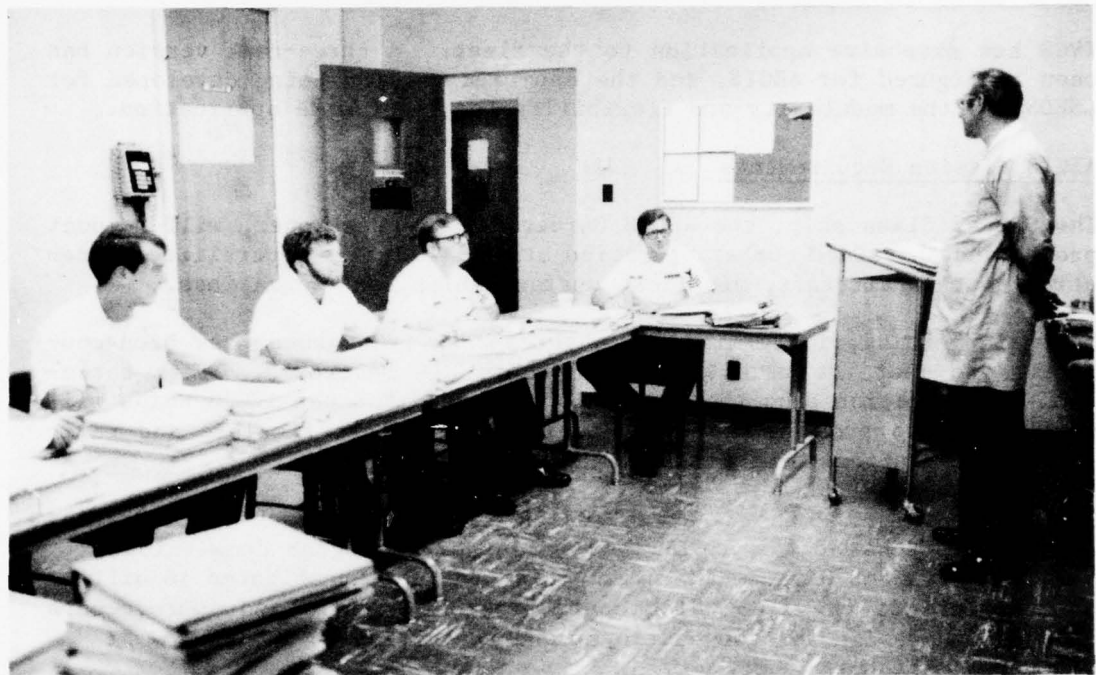
(4) Addition of a portable OOD Station.

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FIGURE 8 LCSF CLASSROOM AND EQUIPMENT LAB

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APPLICATION TO THE FLEET

IVCS has extensive application to the fleet. A three-rack version has been configured for AEGIS, and the one-rack version being developed for CSEDS has the modularity and flexibility for fleet-wide application.

AEGIS Mission Requirements

The DDG-47 Class ship, the AEGIS Guided Missile Destroyer, will conduct prompt and sustained combat operation at sea to deter, neutralize, or destroy hostile aircraft, missiles, surface ships, and submarines.

To perform this primary mission, a three-rack IVCS system has been configured to meet the requirements of the AEGIS Destroyer. This three-rack configuration plus the innovations planned for the AEGIS ships will enable IVCS to provide the fast and responsive, yet flexible and reliable communications demanded by the AEGIS application.

The innovations and the detailed design of the three-rack configuration are the products of the AEGIS IVCS Lead Design Program commissioned by the AEGIS Project Office, PMS 400. This program investigated 18 different elements of the IVCS which could provide benefits and improvements in a common design for the destroyer and the cruiser.

Innovations Planned for AEGIS

As a result of the lead design program, a number of innovations will be implemented in order to completely satisfy all AEGIS requirements. These innovations include:

- New terminals with increased capability

- Integrated Audio Distribution System (IADS)

- Space conserving configuration

- New operational features.

New Terminals. Three new terminal types, ...see figure 9, will provide operational features to allow selective call of individual net members, selected access from a dial terminal of up to five separate lines, and a new automated ship-to-shore capability.

(1) Call Net Terminal ...see figure 10. The Call Net Terminal provides not only the standard "E" or "EM" function for IVCS net terminals but also new and increased operational features. It allows the user to individually call or signal other call net or dial terminals to a

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FIGURE 9 NEW AEGIS TERMINALS

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HANDSET/HEADSET
CONNECTOR

MOUNTING PLATE

ANNUNCIATOR

ILLUMINATION CONTROL
(FOR ACTIVITY IND)

ILLUMINATED LIST

4. 8. OR 16 SELECTIVE CALL
BUTTON ASSEMBLY

ON/OFF SWITCHES

ACCESSORY CONNECTOR
FOR LOUDSPEAKER EXTENSION
OR ADDITIONAL HEADSET/HANDSET

ACTIVITY INDICATOR

HANDSET

CRADLE ASSY

IVCS CABLE CONNECTOR
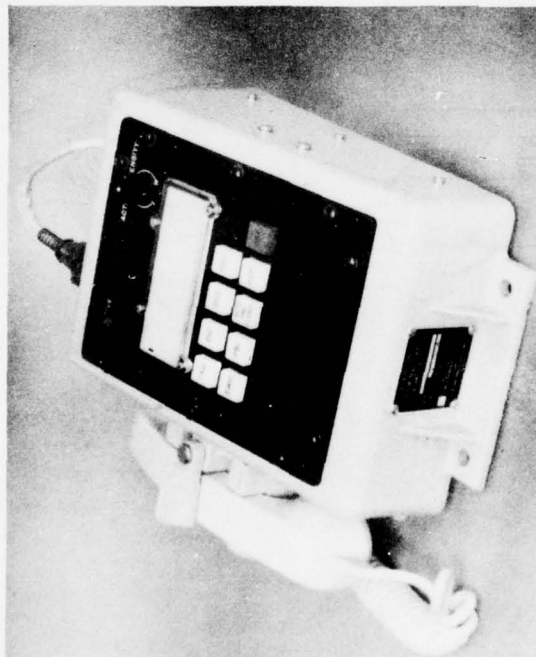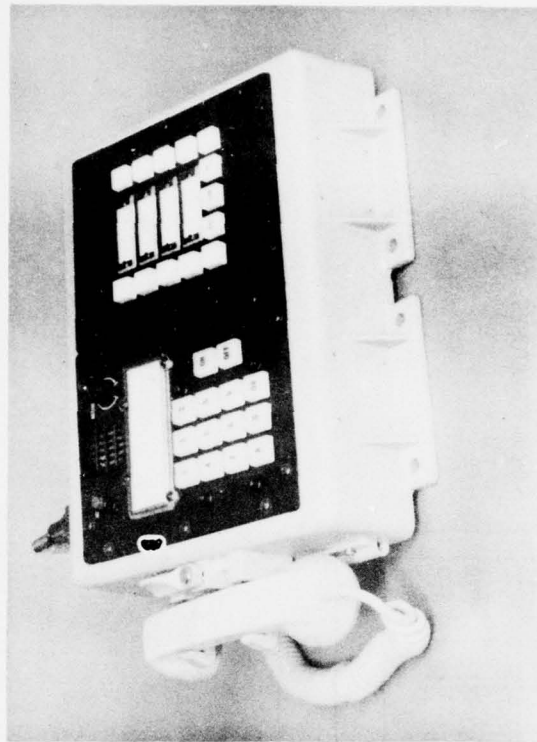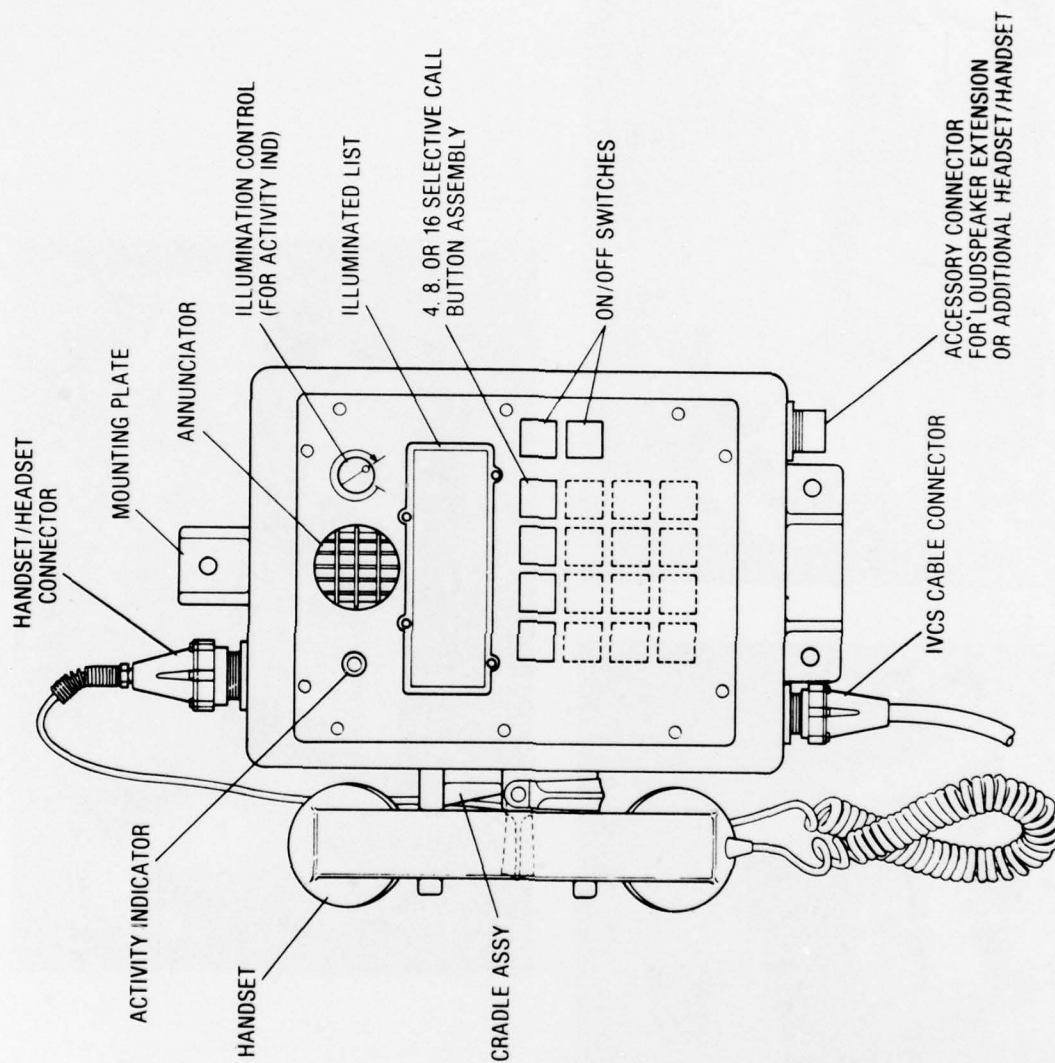
FIGURE 10 CALL NET TERMINAL

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preassigned net. The Call Net Terminal can be configured to provide signalling access to either 4, 8, or 16 other stations through a single pushbutton action.

Additionally, the Call Net Terminal will provide an indication of the net activity. That is, once the Call Net Terminal is activated, a steady on light for any one or more of the 4, 8, or 16 stations indicates that that particular station is busy on the net.

Other lighted indications include a flashing light at the Call Net Terminal of the station that is being called to the net. The station's light will flash at the normal ring rate or a slow rate. Also if the station being called to the net is a dial terminal which is busy on another type of call, the station's light will flash, but at a faster rate equivalent to that of the normal busy tone.

(2) <u>Multiline Dial Terminal ...see figure 11.</u> The Multiline Dial Terminal has been designed to provide access for up to five separate lines. Each line is essentially an individual dial terminal. The new unit allows for remote loudspeaker connections to all lines to enable monitoring, if required. Additionally, the following indications are provided for each line:

(a) Incoming calls to any line are indicated by a flashing SELECT/-ANSWER light in addition to the normal ring alerting tone. When the incoming call has been answered by depressing the appropriate SELECT/ANSWER button, the flashing light will go on steady.

(b) Each incoming call can also be put in the hold and/or monitoring only mode by pressing the talk enable button so that the light goes out. Talk is enabled when the talk enable light for that line is in a steady on state.

(c) A flashing talk enable light indicates that the line is in the hold or monitor mode and the push-to-talk control at the other end has been detected. The user then has the option of turning on the monitor or loudspeaker or depressing the talk enable button to hear what is being said.

The use of the call hold feature with some simple modifications will enable this terminal to perform a call direction function for some ship office space, such as the Engineering Log Room.

(3) <u>Automatic Shore Switchboard ...see figure 12.</u> The new Automatic Shore Switchboard console has been designed to provide modern ship-to-shore communications such as direct inward dialing from the

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NAME PLATE
FOR TELEPHONE
IDENTIFICATION

IVCS CONNECTORS

ACCESSORY
CONNECTORS

ILLUMINATION
CONTROL FOR
ACTIVITY IND.

ANNUNCIATOR

JACK FOR
HANDSET
OR
HEADSET

ILLUMINATION
LIST

HANDSET
RETENTION
CRADLE

PUSH BUTTON
DIAL

SELECT/
ANSWER

WINK ON
RING

TELEPHONE #

(1)

(2)

(3)

(4)

(5)

TALK
ENABLE

WINK ON
P.T.T DET.

OFF

1 2 3

4 5 6

7 8 9

OV O C

LINE SELECT/ANSWER SWITCHES
(INCOMING RING INDICATION &
LINE SELECTED INDICATION)

TALK ENABLE SWITCHES
(INCOMING P.T.T. INDICATION &
TALK ENABLE INDICATION)

TERMINAL
OFF
CONTROL

MOUNTING
PLATE

HANDSET

FIGURE 11 MULTI-LINE DIAL TERMINAL

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JACK FOR HANDSET OR HEADSET

ILLUMINATION LIST

ANNUNCIATOR

ILLUMINATION CONTROL FOR ACTIVITY IND.

IVCS CONNECTORS (1 FWD, 1 AFT)

NAME PLATE FOR TELEPHONE IDENTIFICATION

LINE SELECT/ANSWER SWITCHES (INCOMING RING INDICATION & LINE SELECTED INDICATION)

RELEASE PUSHBUTTON

TALK SHIP, SHORE & NORMAL OR REORDER SWITCHES

HOLD SWITCHES (FLASHING WHEN IN HOLD)

CALL IN QUEUE LAMP (FLASHING WHEN CALLS IN QUEUE)

TERMINAL OFF CONTROL

MOUNTING PLATE

HANDSET RETENTION CRADLE

PUSH BUTTON DIAL

HANDSET

SELECT/ANSWER

HOLD

FORWARD FORWARD AFT AFT

WINK OR RING

OFF

1 2 3
4 5 6
7 8 9
OV 0 C

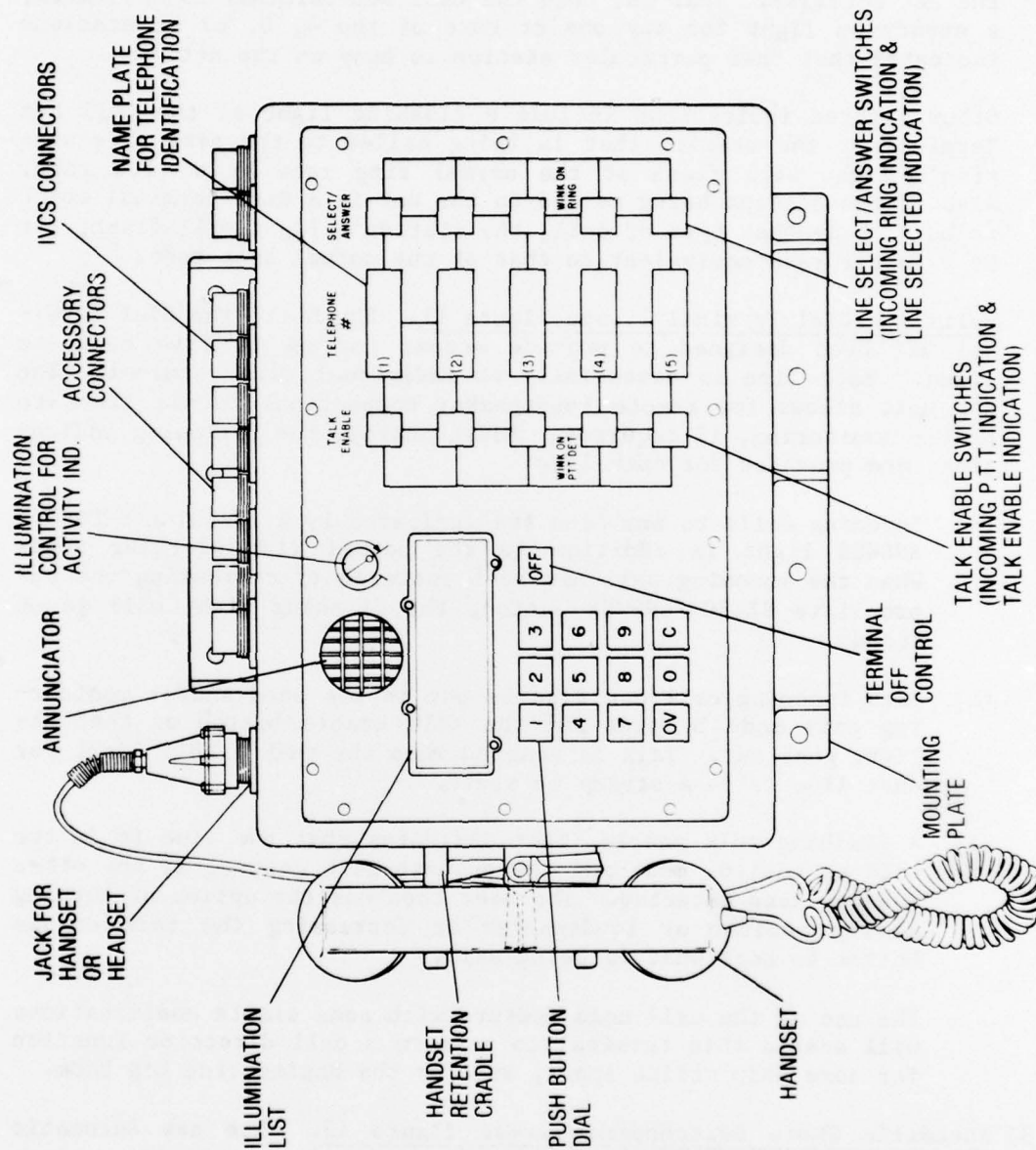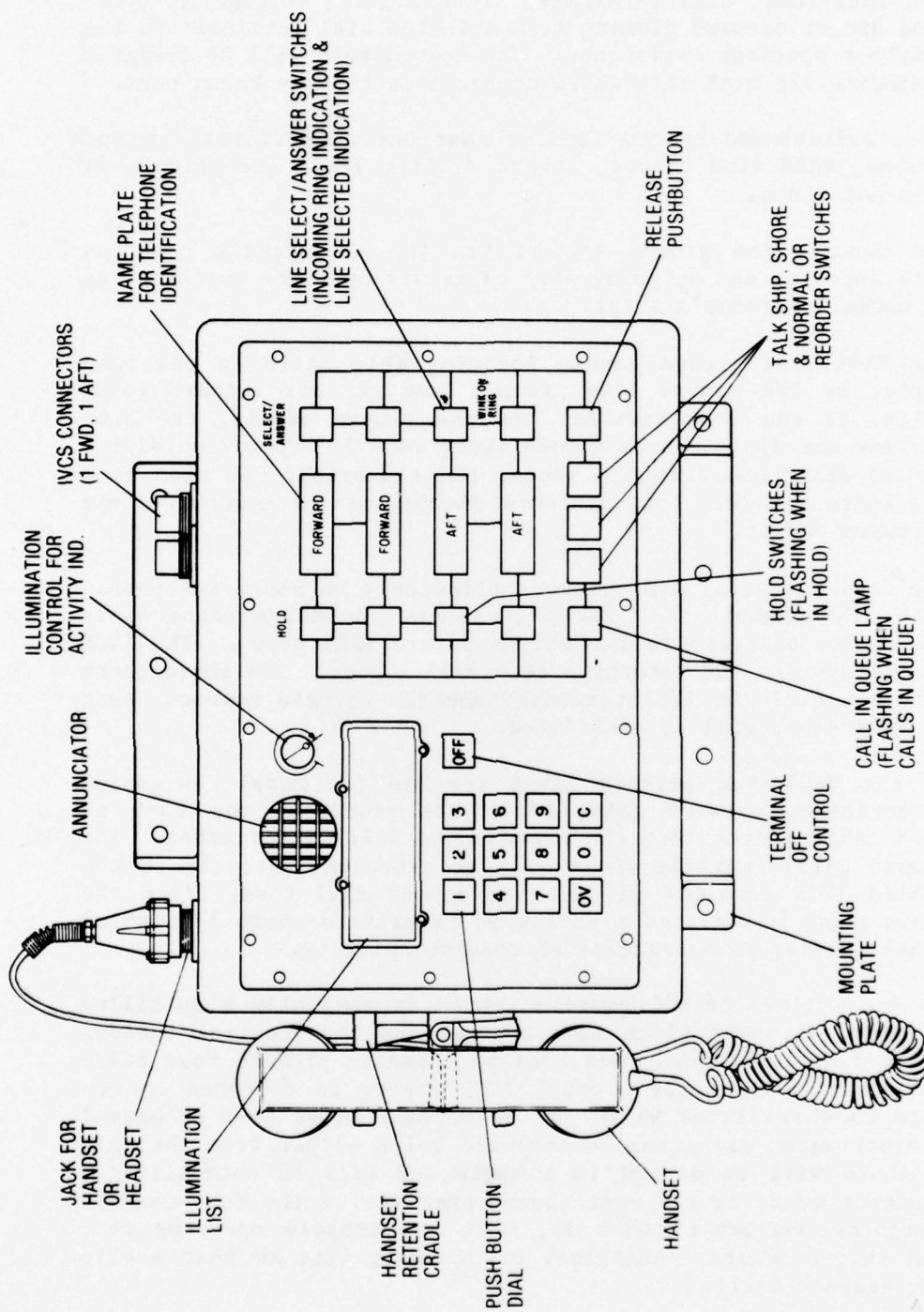**FIGURE 12 AUTOMATIC SHORE SWITCHBOARD**

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shore to individual dial terminals, without going through an operator, and direct outward dialing from selected dial terminals to the shore without operator assistance. The new console will be designed to accommodate all available shore connections for any known port.

The shore switchboard system handles four basic services: manual line groups, PABX line groups, inward dialing lines and private or dedicated hot lines.

(a) The manual line groups all go via the attendant's console. Both incoming and outgoing ship calls are operator assisted, as is normal on today's ships.

(b) The PABX line groups handle incoming ship calls in the same manner as the manual line groups; however, for outward going calls, if the IVCS terminal has the proper permit, the subscriber can dial an escape code (such as 99). Upon receiving a second dial tone from the shore, the subscriber can then dial the shore number. Long distance dialing can be controlled via software permit.

(c) The inward dialing line group applies only to shore telephones with DTMF capability. For this group, the shore phone dials the number assigned to the ship's inward line group. The IVCS switch answers and returns a second dial tone. The shore phone can then dial the IVCS terminal number. Certain numbers, such as PA access, will be restricted.

(d) On the dedicated private lines for one (or more) designated subscribers, outward going calls are processed the same as PABX calls except that the access code will be different. The inward calls from the shore will be processed directly to the called IVCS terminal without any second dial tone, since the shore phone has dialed a dedicated or private shore line which other parties cannot access or receive calls on.

The new shore line control console, which is basically a multiline dial terminal with the fifth line deleted and five control buttons or console functions added, has been designed to process four calls simultaneously. Since the overall IVCS system is designed to accommodate 20 shore lines which can be designated as PABX or manual lines in software, all other switchboard calls either from the ship or the shore will be stored in a queue and will be automatically called out of queue to the switchboard when one of the four console lines becomes available (that is, when the console operator completes a ship-to-shore connection, his console line is then available for another call).

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The new console has been designed to provide simplified call controls and easy to recognize call indications. And although its capability is far superior to that on the LHA, the new console is considerably smaller and easier to use.

IADS. Another innovation implemented in the AEGIS IVCS system is that of the Integrated Audio Distribution System (IADS). IADS essentially is the interface between the shipboard interior communication system (IVCS) and the NTDS console intercommunication system, the AN/UYQ-21, on the AEGIS ships ...see figure 13. IADS provides to the console operator at his headset a single audio system for all his communication functions, thereby eliminating the multiplicity of devices at the console normally present for either console intercommunications, secure radio or the multiple interior communication functions. The secure communication function in IADS is accomplished by the interface between the SAS system and the AN/UYQ-21. The IADS interface hardware is provided as a part of the IVCS.

IADS provides a greater overall communications system effectiveness, improves the console operator's efficiency and increases his response time, while reducing the overall quantity of shipboard equipments and providing greater system flexibility.

Space Conserving Configuration. The three-rack IVCS configuration has been designed for the AEGIS application instead of the five-rack LHA configuration to optimize the switching center design in order to reduce acquisition cost and to save space and weight. All of the IVCS redundant hardware and software control features have been retained.

The three-rack version employs a single combined power control/power supply rack due to the reduced AEGIS power requirements vs the two-rack power scheme in LHA. The three-rack version also employs a single common control rack which houses the redundant processors as in LHA. However, this rack has been repartitioned to utilize only three of the four vertical drawers for control/interface functions. Additionally, the three-rack version employs reed relay switching as does the LHA system. However, AEGIS requires only a single, four-drawer switching rack, with expansion to a fifth drawer (the unused drawer in the common control rack if required) vs the two-switching rack, seven-drawer configuration found in LHA. For the dual center system, this results in a hardware savings of four racks for each AEGIS platform.

New Operational Features. The other current innovations for AEGIS involve the introduction of new operational or subscriber features. These new features were primarily derived as lessons learned from the LHA application. The features include using a 16-pushbutton dial terminal for more abbreviated addresses per terminal.
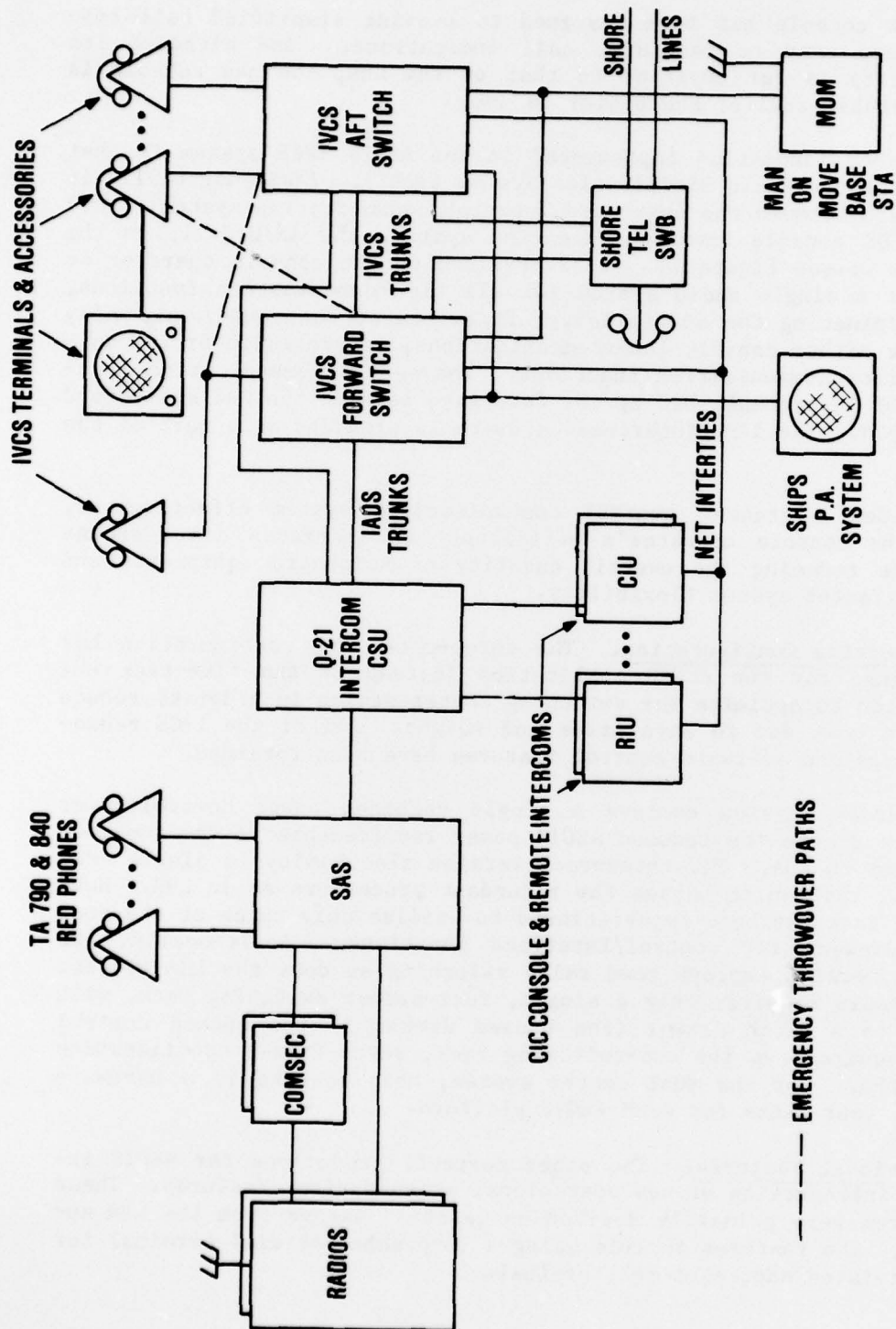
FIGURE 13 IADS BLOCK DIAGRAM

For all dial terminals, a call forwarding indication will be added to alert the subscriber when the terminal has been call forwarded. Additionally, single pushbutton actions will be employed for common features. For example, instead of dialing 9702 for a conference call, a conference call button (designated C) will be employed. To effect override, the user will no longer have to get a busy signal, hang up, go on hook again, hit the OV button, and then redial the call. On AEGIS if a busy signal is received, the user - if given the permit - will simply hit the OV button without redialing to override or break in. Furthermore, on AEGIS we are considering employing single-button abbreviated addressing and five-button normal dialing (a D prefix and a four-digit number) vs the two-button abbreviated addressing (an A prefix and the number) and the normal four-button or digit dialing employed in LHA.

The AEGIS IVCS will also possess the capability of recorded messages for such items as time, plan of the day, movie of the day, etc.

Fleet-Wide Application

The ultimate goal of the IVCS program is to provide a system capability applicable to all ship sizes, from the smallest to the largest and for all ship's missions, from the least sophisticated to the most demanding.

The utilization of recent technological advancements have paved the way for the consideration of certain hardware improvements which will allow for the cost-effective application of a single-rack configuration to meet the entire Fleet's needs.

The hardware improvements include the utilization of time division switching, ...see figure 14, and the utilization of microprocessors with solid-state memories, ...see figure 15. The resulting single-rack configuration is planned for installation in CSEDS.

The single-rack configuration, ...see figure 16, will retain all the major IVCS features such as hardware redundancy, software control and modular expansion. The new design will result in a lower cost system, one-rack instead of five, and will be a nonblocking switching system which will be a more reliable system, due to its' total solid-state design; the solid-state design will, in turn, result in a much more simplified maintenance load.

Application to All Ship Sizes. The single-rack system will be applicable to all ship sizes, ...see figure 17, due to its highly modular expansion capability. The maximum system design capacity for the single-rack configuration is 400 lines or 800 lines for a dual-center installation. The system is applicable to smaller ship applications such as the FFG or PHM by simply depopulating the card count in the single-rack. On the other hand, the single-rack design easily expands upward by simply
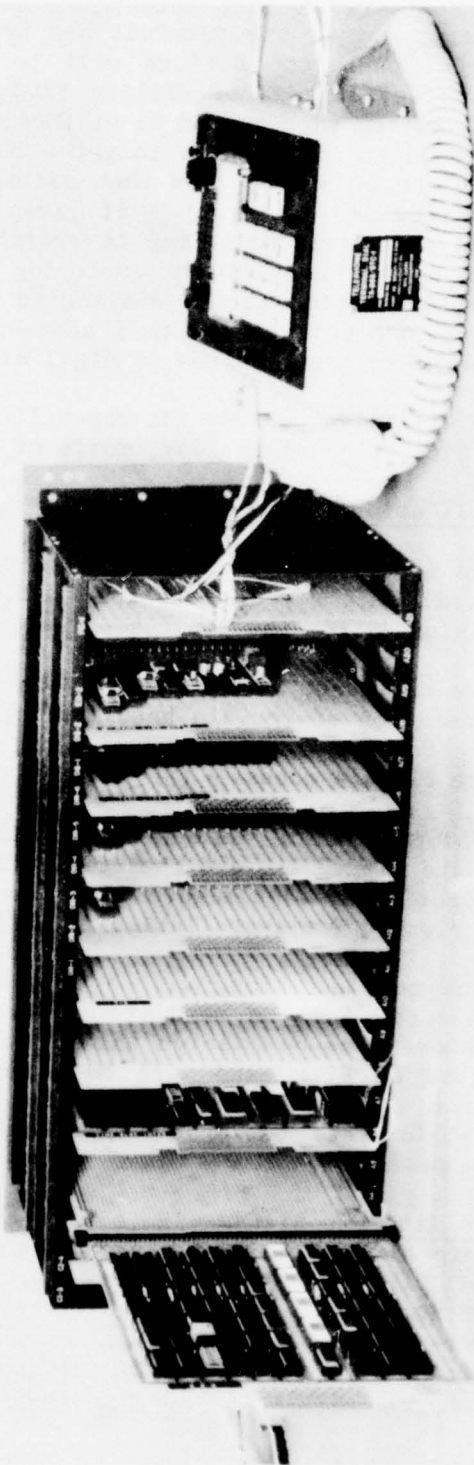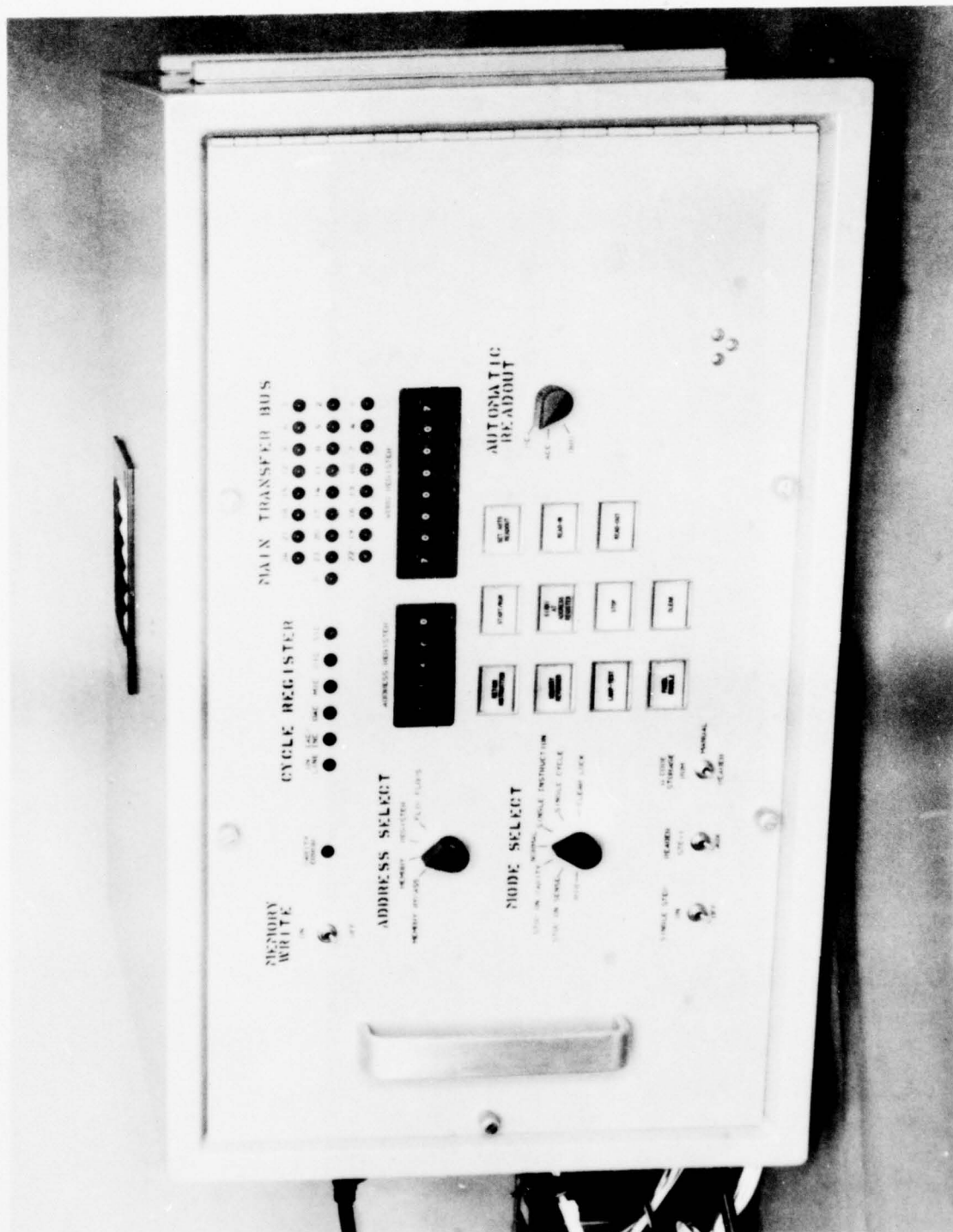
FIGURE 14 TIME DIVISION SWITCH

30
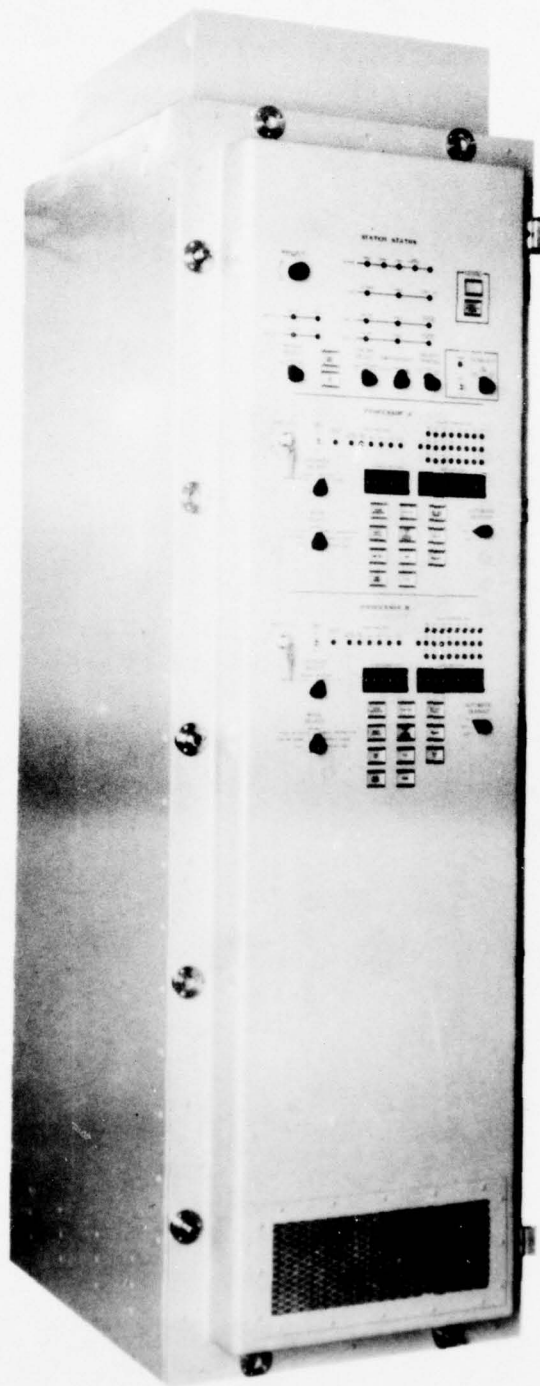
FIGURE 15 SOLID STATE MEMORY AND MICROPROCESSOR
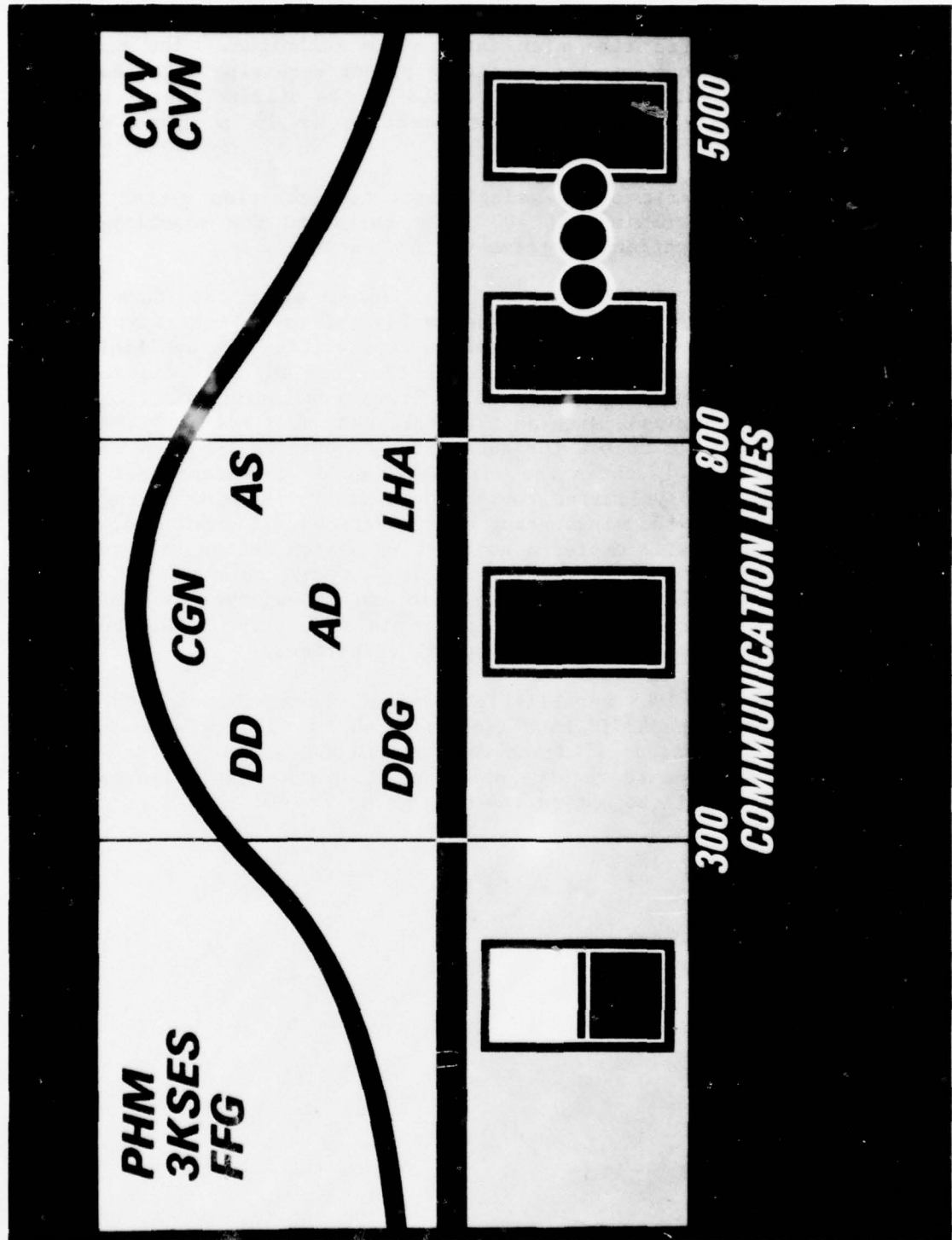
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FIGURE 16 SINGLE-RACK CONFIGURATION

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FIGURE 17 COST-EFFECTIVE APPLICATION TO ALL SHIP SIZES AND MISSIONS

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adding identical racks. The racks in a large application, such as the approximate 5000 lines required for a CVN, are easily interconnected through a simplistic time slot interchange technique. The time slot interchange technique has the advantage of not requiring high amounts of interconnecting cables between the racks or the utilization of valuable switching capacity for rack interconnection as in a space division system.

An additional benefit of the single-rack configuration system is that its' design for a maximum of 400 lines satisfies the majority of all known system applications in terms of line capacity.

Application to All Ship Missions. The other major consideration for future IVCS systems is that they be configured to satisfy ship mission requirements. The existing IVCS system capabilities are available to be included in the system design or application for any ship class. These capabilities, applicable to the single-rack configuration, include the versatile IVCS terminals such as the dial, net, call net, multiline, and automatic, which all enable the subscriber to utilize the many modern IC features available (such as the various types of conference calls, even the capability for unlimited conference calls or conference call sizes which is unique to the single-rack configuration). In addition, the future IVCS systems will employ a nonblocking system design instead of the 0.001 grade of service for the LHA system, as well as a TEMPEST design. The systems will employ extensive radio and man-on-the-move interfaces as well as the automatic shore telephone interface, the IADS, the public address (1MC), data transmission, and TV interfaces.

Table 1 lists the IVCS capabilities presently available and the extent to which LHA and the AEGIS base line make use of them. These capabilities have evolved since 1963 and more are in the works. Future installations are expected to require newer and even more extensive capabilities, and these will be met as the need arises.

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IVCS Capability	Fleet 1980	LHA 1969–75	AEGIS Base Line 1977–78
Configuration	1	5	3
Dial	x	x	x
Net	x	x	x
Call Net	x		x
Multiline	x		x
Automatic	x	x	x
Modern IC Features	x	x	x
Conferences			
• Random	x	x	x
• Preset	x	x	x
• Unlimited	x		
Nonblocking	x		
TEMPEST	x		
Radio	x	x	
MOM	x	x	
Auto Shore	x		x
IADS	x		x
PA	x	x	x
Data	x		
TV	x		

Table 1. Capabilities Available in Present or
Planned IVCS Configurations